MULTIMEDIA UNIVERSITY

STUDENT ID NO

					1	2	5	7	8

SEAT NO: _____

SECTION: TC01 / TC02 / TC03

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

TCP2101 – ALGORITHM DESIGN AND ANALYSIS

(All Sections / Groups)

03 MARCH 2018
2.30 p. m. – 4.30 p. m.
(2 Hours)

Question	Mark
1	
2	
3	
4	
Total	

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 13 pages with 4 Questions only.

2. Answer all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in **this Question paper**.

Question 1

a) An algorithm **findM** is provided below. Fill in the column named Number of Primitive Operations, and find the time complexity $T(n)$ of the algorithm in big-O notation. [7 marks]

Algorithm **findM**(A) Input: A is an array with n integers	Number of primitive operations
count_3_same ← 0	
for i ← 0 to n-3 do	
they_are_same ← TRUE	
for j ← i + 1 to i + 2 do	
if ($A[i]$!= $A[j]$)	
they_are_same ← FALSE	
if (*they_are_same*)	
count_3_same++	
return *count_3_same*	
$T(n)$	

b) What is the **return value** of the algorithm above if array A = {1, 2, 2, 2, 3, 3, 4, 4, 4, 5, 6, 6, 7, 7, 7}? [2 marks]

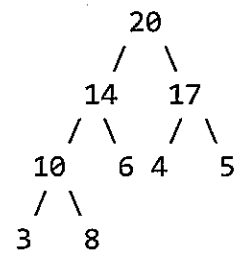
Continued...

c) **Chaining** and **linear probing** are two of the collision resolution techniques in hash tables. Which technique is more **space efficient**? **Explain** your answer briefly. [4 marks]

d) Insert the integers in the following order, 40, 27, 29, 24, 37, 25, and 65 into a hash table using this hash function, h(x) = k % 13. Use **linear probing** to handle collision in the hash table. [8 marks]

Continued...

e) The following **maxheap** is provided. **Two dequeues** are performed on the heap. **Draw** the resulted heap after **each dequeue**. Show your steps. [4 marks]



Continued...

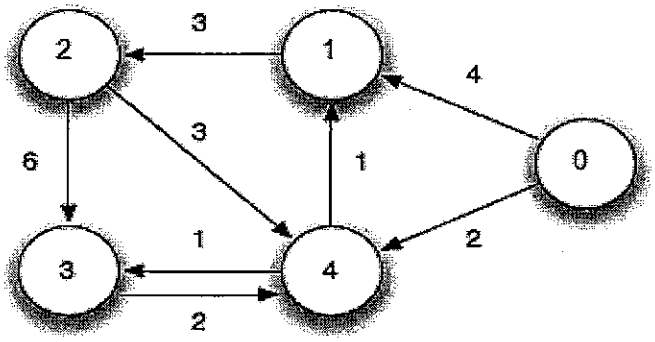
Question 2

a) Based on the sequence of numbers provided below, create an **AVL. Show** the steps. [8 marks]

55 75 66 12 28

Continued...

b) What is the **space complexity** (in big-O notation) for implementing a graph using an **adjacency matrix**? **Draw** the adjacency matrix the following graph. [5 marks]



c) The incomplete pseudocode for the algorithm named *TopologicalSort* is given below. **Complete** the pseudocode (line 4-7) for the algorithm and state its **time complexity**. [6 marks]

```
Algorithm TopologicalSort(G)
Input: Graph G with n vertices
Output: topological ordering of G
1. H ← G  //temporary copy of G
2. n ← G.numVertices()
3. while H is not empty do
// start your codes here!
4.
5.
6.
7.
// end your codes here!
```

Continued...

d) **What** is the following algorithm *XYZ* used for? State the **time complexity** for this algorithm. Given an array with 5 integers, $S = \{23, 12, 6, 11, 7\}$ and algorithm *XYZ* was performed on this array. Print the elements in *S* after the execution of the algorithm. [6 marks]

```
Algorithm XYZ (S, n)
  for i ← n-1 until 1 do
     maxIndex ← i
     for j ← 0 until i-1 do
         if (S[j] > S[maxIndex])
            maxIndex ← j
     {increment counter j}
     if (maxIndex != i)
      swap (S[i], S[maxIndex])
   {decrement counter i}
```

Continued...

Question 3

a) **Explain** briefly what is an **in-place** algorithm? Name TWO in-place sorting algorithms and state the **worst-case time complexity** for each of them. [6 marks]

b) The following list A contains integers. **Show** (in steps) how to use the **quick-select** algorithm to find the **6-th smallest** integer in the list. This algorithm selects the **left-most** element as pivot in each partition step. [6 marks]

$A = \{7, 4, 11, 2, 6, 8, 1, 10\}$

Continued...

c) Use the Master Theorem to find the running time for the following two recurrence equations. The three cases of the Master Theorem are given below. [4 marks]

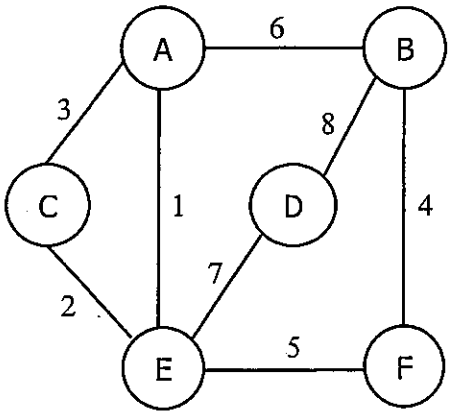
1. if $f(n)$ is $O(n^{\log_b a-\varepsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a}\log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a}\log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a+\varepsilon})$, then $T(n)$ is $\Theta(f(n))$,
   provided $af(n/b) \le \delta f(n)$ for some $\delta < 1$.

i) $T(n) = 9T(n/3) + n^3$

ii) $T(n) = 4T(n/4) + n \log n$

Continued...

d) State the **time complexity** for **Kruskal's** algorithm. Use Kruskal's algorithm to find the minimum spanning tree (MST) for the following graph. Show the **steps** (intermediate graphs). State the **total weight** of the MST. [9 marks]



Continued...

Question 4

a) State **one similarity** and **one difference** between complexity classes P and NP. [3 marks]

b) An incomplete **fractionalKnapsack** algorithm is provided below. Complete the algorithm. [5 marks]

Algorithm ***fractionalKnapsack*** **(*S, W*)**
Input: set ***S*** of n items with benefit b_i and weight w_i; max weight W
Output: amount x_i of each item i to maximize benefit w/ weight at most W

```
for each item i in S
      xi ← 0
      vi ← bi / wi                {value}
w ← 0                             {total weight}
while w < W
```

Continued...

c) The following text X is provided. How many **bits** are required to encode X if **Huffman Encoding** is used to encode X? Show your calculation. [9 marks]

X = BCBPQBP

Continued...

d) Given the following five items, each with a weight and a benefit, determine the **maximum total benefit** that can be obtained by selecting some of the items (show your calculation). The combined total weight W shall not exceed **9kg**. You are **not allowed** to take fractional amount of an item. State the **name** of the algorithm should be chosen to solve the problem, and its **time complexity**. [8 marks]

Item	A1	A2	A3	A4	A5
Weight (kg)	3	2	4	5	1
Benefit	7	6	10	15	22

End of Page